Meeting

11/04/2022

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Monoenergetic beam

SOBP (Spread Out Bragg Peak)

Pristine Bragg Peak
Motivation:
Evaluation and assessment of the near field of 3D range modulators.

Fluence distribution in xy plane
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Evaluation and assessment of the near field of 3D range modulators.

Carbon with 400.1 MeV/u

For conventional treatment: need homogeneous field on Water phantom or Patient’s skin

Fluence distribution in xy plane
Outline of the work to do:

1.) + Nearfield simulation of **2D SOBP modulator (for a simple 5 cm Proton SOBP)**
   
   + *Fluence distribution* in air in order to assess in which distance does the fluence ripple disappear
   
   + *Dose distribution* of the dose inhomogeneities in water, in particular for small distances of the filter

2.) Same for a real **3D modulator** (to be defined which tumor shape), could be a lung tumour

3.) Assessment and discussion of the dose inhomogeneities

![2D Range Modulator](image1.png)

![3D Range Modulator](image2.png)
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Ongoing work: Simulate 2D range modulator

- Develop user routine code (USRMED.f) for 2D range modulator and ripple filter
- Translate MATLAB code to FORTRAN and implement in FLUKA
- Check beam field to irradiate
- Check the fluence in air every 2 cm

Proton 150 Mev

60 cm

2 cm
Develop user routine code (USRMED.f) for 2D range modulator and ripple filter

- FLUKA input file: hard to create complex geometry
- User routine take responsibility \(\rightarrow\) Faster
Develop user routine code (USRMED.f) for 2D range modulator and ripple filter

**Pin data:** Vertices, normal vectors

**User routine:** calculate intersection length

**Triangles:**
- Coordinates \([x, y]\)
- Directional vector

Shift \((\Delta x, \Delta y, \Delta z)\) along the directional vector

**Examples:**
- \(D = 6\ mm + 2\ mm\)
- \(D = 8\ mm\)
Develop user routine code (USRMED.f) for 2D range modulator and ripple filter

Pin data file: Height, Radius
Translate MATLAB code to FORTRAN and implement in FLUKA
Check beam field to irradiate

- Try square field
Check beam field to irradiate

- Multiple Gaussian beams: FWHM = 8 mm, Spot spacing 5 mm
Check beam field to irradiate

- Multiple Gaussian beams
Check beam field to irradiate
Check the fluence in air every 2 cm

Dose distribution

Depth in water (cm)
Check the fluence in air every 2 cm

Proton fluence

Increase statistics!
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- Investigate dose distribution in water at homogeneous field

Next step: Simulate 3D range modulator (could be a lung tumour)
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- Analyze data by using Python code
- Observe more energies: 100 MeV, 220 MeV, 250 MeV
- Modify user routine code for ridge filter

Next step: Simulate 3D range modulator (could be a lung tumour)
Check the fluence in air every 2 cm

Proton 150 MeV

Pin period = 3.0 cm

5.0 cm

2 cm

Air

30 cm
\[ F = \frac{R_{\text{max}} - R_{\text{min}}}{R_{\text{max}} + R_{\text{min}}} \]
Minimum plane (x = 0 cm)

Maximum plane (x = 0.15 cm)

Pin period 3.0 cm

Modulator is at Z = 0 cm
Maximum plane (Z = 15 cm)
\[ F = \frac{R_{\text{max}} - R_{\text{min}}}{R_{\text{max}} + R_{\text{min}}} \]
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Thank You